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Gasteroid mycobiota of Rio Grande do Sul, Brazil: *Tulostomataceae*

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Abstract — The diversity of *Tulostomataceae* has been investigated in Rio Grande do Sul State in southern Brazil. Eight species belonging to two genera were recognized: *Battarrea,* represented by *B. phalloides,* and *Tulostoma,* represented by *T. brasiliense, T. cyclophorum, T. dumeticola, T. exasperatum, T. pygmaeum, T. rickii,* and *T. striatum.* All species are described and illustrated by line drawings and photos, including scanning electron micrographs of the basidiospores. Illustrations of the peridium structure are furnished for most taxa.

Key words — *Agaricales,* gasteromycetes, stalked puffballs

Introduction

The family *Tulostomataceae* E. Fisch. (*Basidiomycota*) comprises stalked puffballs belonging to the genera *Battarrea* Pers., *Battarreoides* T. Herrera, *Chlamydopus* Speg., *Queletia* Fr., *Schizostoma* Ehrenb. ex Lév., and *Tulostoma* Pers. (Kirk et al. 2001). Among these, only *Battarrea* and *Tulostoma* have been reported in Brazil, although species of *Chlamydopus*, *Queletia*, and *Schizostoma* are known in Argentina and other neighboring countries (Wright 1949, Mahú 1980, Dios et al. 2004). *Tulostoma* is the largest genus, with more than 140 species, occurring mainly in xerophilous habitats, and to a lesser extent, in forest environments (Wright 1987).

Tulostomataceae was recently included in the *Agaricales* Underw. based on studies of molecular systematics (Moncalvo et al. 2002); within this order, it has been considered as a separate family (Kirk et al. 2001) or merged into the heterogeneous *Agaricaceae* Chevall. (Vellinga 2004), which currently includes agaricoid, secotioid, and gasteroid members (Kirk et al. 2008).

In Brazil, studies on *Tulostomataceae* were done by Rick (1907, 1930, 1961), who reported seven *Tulostoma* and one *Battarrea* from Rio Grande do Sul State. Batista & Vital (1955) described three new *Tulostoma* from Pernambuco (*T. heroicum* Bat. & A.F. Vital, *T. nanicum* Bat. & A.F. Vital and *T. recifense* Bat. & A.F. Vital), all of them now considered synonyms of *T. cyclophorum* (Wright 1987). In his world monograph of *Tulostoma*, Wright (1987) reported eight species in Brazil, mostly from Rio Grande do Sul State. More recently, new data on *Tulostomataceae* in areas of northeastern (Baseia & Galvão 2002, Silva et al. 2007a, b), southeastern (Baseia & Milanez 2002), and southern (Cortez et al. 2008a, b) Brazil have improved the knowledge on the distribution of the group in the country.

The aim of this work is to revise the *Tulostomataceae* in Rio Grande do Sul State mycobiota based on study of fresh and herbarium specimens.

Materials and methods

Specimens were collected from 2006 to 2008 in Rio Grande do Sul State, southern Brazil. Specimens from the herbaria BAFC, HURG, ICN, PACA, and SMDB were revised. Descriptive terminology and taxonomy is based in Wright (1987). Color codes follow Kornerup & Wanscher (1978). Scanning electron microscopy (SEM) studies were performed at the Universidade Federal do Rio Grande do Norte with a Phillips XL 20, following previously described methods (Cortez et al. 2008c). All collected specimens are deposited at the herbarium ICN, with some duplicates at UFRN and SMDB.

Taxonomy

Key to the *Tulostomataceae* of Rio Grande do Sul State, Brazil

1. Volva present, mouth absent, elaters present ..... **1. *Battarrea phalloides***
1'. Volva absent, mouth present, capillitium present (***Tulostoma***) 2
2. Mouth tubular 3
2'. Mouth circular, fimbriate to indistinct 4
3. Exoperidium hyphal ..... **6. *T. pygmaeum***
3'. Exoperidium membranous ..... **2. *T. brasiliense***
4. Growing on wood, exoperidium spiny ..... **5. *T. exasperatum***
4'. Growing on soil, litter or sand, exoperidium not spiny 5
5. Growing on sand or sandy soil, stipe smooth ..... **8. *T. striatum***
5'. On soil or litter in forests, stipe scaly to lacerated 6
6. Mouth mammose, fimbriate ..... **3. *T. cyclophorum***
6'. Mouth circular, fimbriate 7
7. Stipe with a bulbous, pseudovolvate base ..... **7. *T. rickii***
7'. Stipe with an expanded, not bulbous, base ..... **4. *T. dumeticola***

Description of the studied taxa

1. *Battarrea phalloides* (Dicks.) Pers., Syn. Meth. Fung.: 129, 1801. Fig. 1–4, 44

Basidiomata 195–330 mm high, epigeous in mature stage. Spore sac 22–60 × 16–21 mm, hemispheric, brown (6E5) to light brown (6D5), upper surface velutinous to densely fibrillose and dry, margin crenate to eroded. Mouth absent. Gleba pulverulent, light brown (6D6). Stipe 190–313 × 5–22 mm, cylindrical to slightly sinuous, surface scaly to fibrous, light brown (6D7) to brown (6D8), hollow, base volvate. Volva membranous, presenting similar color and surface as the stipe, partially adhered to the stipe base.

Basidiospores 5–6 µm diam. (including ornamentation), subglobose to globose, yellowish brown in KOH, with an ornamentation composed by short cylindrical spines; under SEM, the ornamentation is composed by warts and short spines which are anastomosed forming a subreticulate pattern. Pseudocapillitium 3–5.5 µm diam. hyphae, yellowish to hyaline, with thin walls, septa and branching uncommon. Elaters 3.5–6 µm diam., cylindrical, hyaline, with thickened spiral ornamentation, little branched.

Examined specimens: BRAZIL. Rio Grande do Sul State. **Nova Petrópolis**, X.1994, *G. Sobestiansky* (ICN 102570), in subtropical ombrophilous forest; **Tupanciretã,** Taquarembó, *J. Rick* (PACA 12606).

Additional specimens: ARGENTINA. **Salta Province**, 1983, *R.T. Guerrero* (ICN 97585).

Distribution: worldwide in xerophilous areas (Watling et al. 1995, Esqueda et al. 2002). Brazil: Pernambuco (Silva et al. 2007b, as *B. stevenii*) and Rio Grande do Sul (Rick 1961, Sobestiansky 2005).

Discussion: This fungus can be considered a rare species in Rio Grande do Sul, since only herbarium specimens were studied. It usually occurs in sandy and dry areas, but the Sobestiansky (2005) collection was gathered in ombrophilous forest of south Brazil. *Battarrea stevenii* (Libosch.) Fr., considered a distinct species by many authors (Watling et al. 1995), was shown to be synonym of *B. phalloides* based on morphological and molecular data (Martín & Johannesson 2000, Jeffries & McLain 2004). The differences in basidiomata size and consistency of the volva – the main features used to separate them – are due to variation in the environmental factors of their habitats (Jeffries & McLain 2004).

2. *Tulostoma brasiliense* J.E. Wright, Ciencia 27: 112, 1972.

Description: see Wright (1987) and Wright et al. (1972).

Distribution: southern hemisphere. Brazil, Argentina and Australia (Wright 1987, Grgurinovic 1997). Brazil: Rio Grande do Sul (Wright et al. 1972).

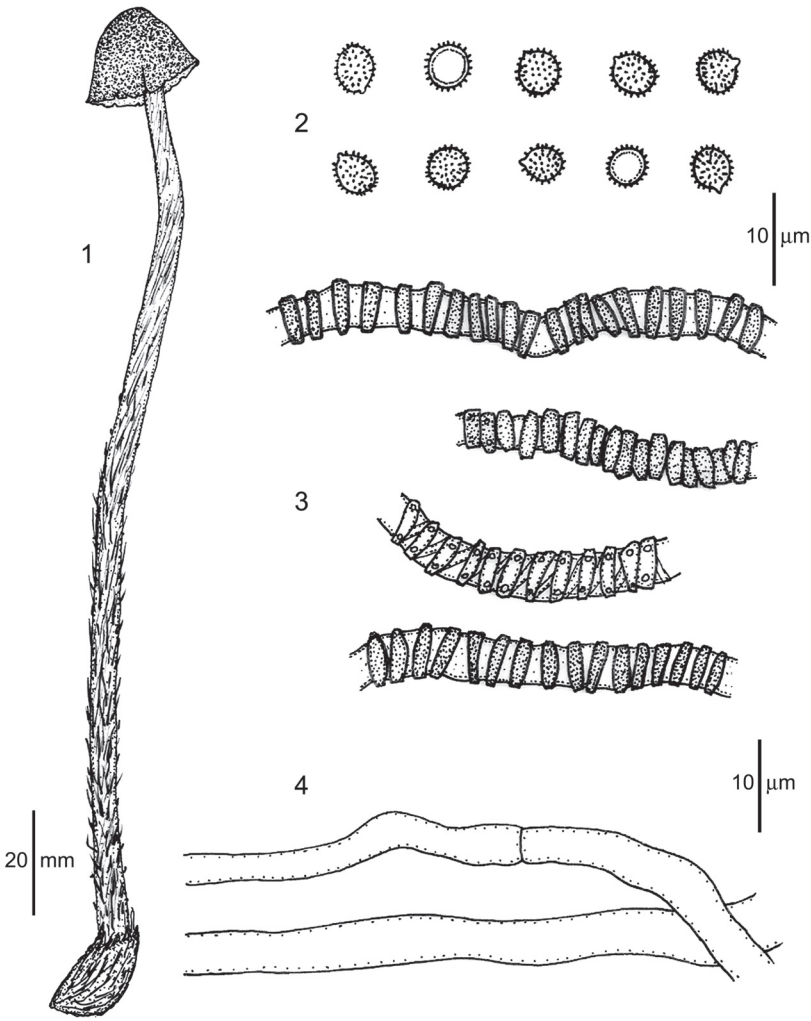

Fig. 1–4. *Battarrea phalloides.*
1. Basidioma. 2. Basidiospores. 3. Elaters. 4. Pseudocapillitium.

Discussion: *Tulostoma brasiliense* is known in Brazil only from the holotype, preserved at Lloyd's herbarium (BPI). Unfortunately, the type was requested but could not be studied because it was lost during mail sending. For this reason its description is not presented here. According to Wright (1987), it resembles

T. xerophilum Long in some aspects but this species has minutely echinulate basidiospores, in contrast to verrucose basidiospores of *T. brasiliense*. In spite of our efforts to recollect *T. brasiliense*, no specimens were gathered, a common situation for many species described and reported by J. Rick.

3. *Tulostoma cyclophorum* Lloyd, Tylostomeae: 25, 1906. Fig. 5–10, 45

Basidiomata 51–67 mm high. Spore sac 13–16 mm diam., 9–11 mm high, hemispheric to depressed-globose. Exoperidium membranous, mostly seen on young basidiomes, loosing from endoperidium as plates in maturity, light brown (6D5) to brown (6E5) externally, and white inside. Endoperidium membranous to tough, with a furfuraceous surface due to the numerous mycosclereids, color brownish orange (5C3) to dark blond (5D4). Mouth definite, fibrillose-fimbriate, mammose, color the same of the endoperidium. Socket conspicuous, well-developed, separate from the stipe, forming a membranous, scaly to lacerate collar around the stipe apex. Gleba lanose to little pulverulent when mature, brownish yellow (5C7) to golden brown (5D7). Stipe 45–62 × 2.5–4 mm, cylindrical to slightly curved, base expanded, with abundant, thin rhizomorphs, surface longitudinally striate with scattered scales (decortications of stipe surface), color brown (6E5), fistulose, with white context.

Basidiospores 3.8–5 × 3.4–4.2 µm diam. (including ornamentation), ovoid to subglobose, with a verrucose ornamentation under light microscopy, stramineous in KOH; under SEM the ornamentation the warts are anastomosed, forming a reticulum. Capillitium 3.4–8.4 µm diam. hyphae, with hyaline to stramineous walls, moderately thickened, septate and little branched. Endoperidium formed by mycosclereids 72–226 × 20–28 µm, short to elongated, some with nodules or irregular branches, walls thickened, yellow to brownish yellow in KOH, present in the endoperidium surface.

Examined specimens: BRAZIL. Rio Grande do Sul State. **Ibirapuitã:** 08.IV.2007, *R. Sühs* (SMDB 11.118). **Porto Alegre:** *Schneider* (PACA 22185, as *T. pygmaeum*); Chácara Irmãos Maristas, 01.VI.1968, *Feliciano* (ICN 5365); Morro Santa Teresa, 10.V.1971, *M.L. Lorscheitter* (ICN 6221). **Rio Grande:** FURG Capus Carreiros, 18.III.1991, *B. Vall* (HURG 3590); Cassino, 18.III.1992, *A. Görgen* (HURG 3712); Querência, 16.VII.199, *T.S. Gonzalez* (HURG 3792). **Santa Cruz do Sul:** UNISC, 18.VI.2007, *M.A. Sulzbacher 112* (SMDB 11.119). **Santa Maria:** 1935, *J. Rick* (PACA 15074, 15081, 15087); 1936, *J. Rick* (PACA 15084). **São Leopoldo:** *J. Rick* (PACA 15085, as *T. rickii*); 1930, *J. Rick* (PACA 15069, 15072); 1936, *J. Rick* (BAFC 51652). **Viamão:** Schöenwald, 19.V.1965, *M.H. Homrich* (ICN 3653, 3655), 21.VII.1965, *R. Schöenwald* (ICN 3777), 14.VIII.1965, *Schöenwald* (ICN 3837).

Additional specimens: ARGENTINA. **Buenos Aires:** Estación Experimental Central, 30.V.1956, *A. Marzzocca* (ICN 3513). URUGUAY. **Montevideo**: Tonkinson, 28.IV.1934, *W.G. Herter* (PACA 94552).

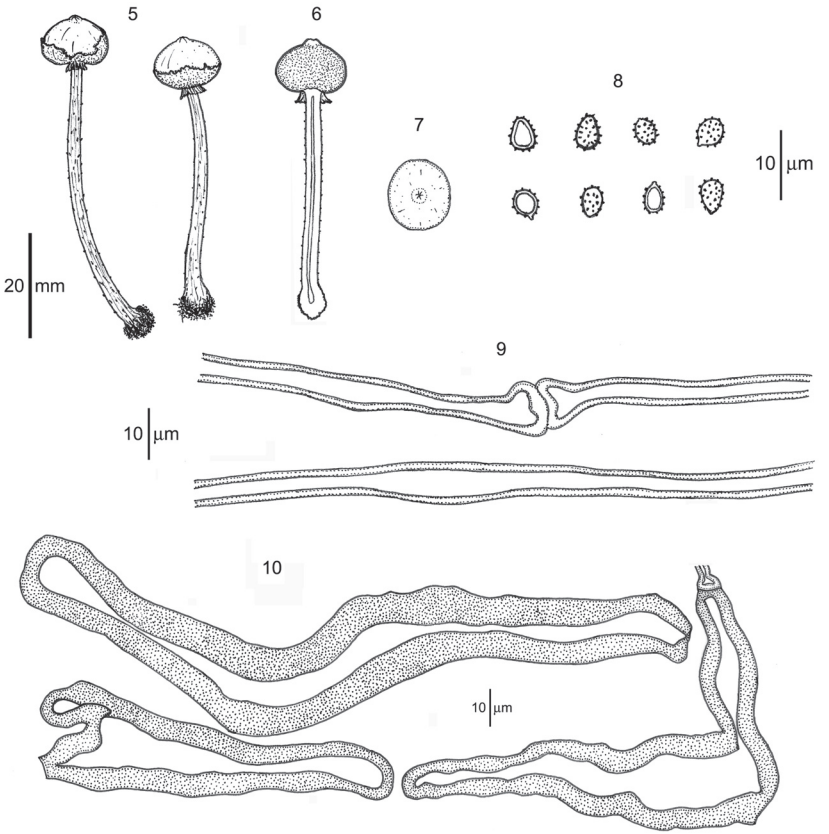

Fig. 5–10. *Tulostoma cyclophorum*.
5. Basidiomata. 6. Section of basidioma. 7. Top view of spore sac.
8. Basidiospores. 9. Capillitium. 10. Mycosclereids.

Distribution: worldwide (Wright 1987). Brazil: Rio Grande do Norte (Silva et al. 2007a), Pernambuco, Rio de Janeiro, Santa Catarina, and Rio Grande do Sul (Wright 1987).

Discussion: *Tulostoma cyclophorum* was considered by Wright (1977) to be a synonym of *T. pampeanum* (Speg.) J.E. Wright. However, as pointed out by Demoulin (1984), Wright's new combination does not have priority at the species level because the epithet '*pampeanum*' was originally described in the rank of form. The combination of membranous exoperidium, mammose mouth and the presence of mycosclereids on endoperidium are the diagnostic features of the species (Wright 1987). *Tulostoma cyclophorum* was previously reported

in Rio Grande do Sul by Rick (1930, 1961), Wright (1987) and Guerrero & Homrich (1999, as *T. berteroanum*).

4. *Tulostoma dumeticola* Long, Lloydia 10: 117, 1947. Fig. 11–16, 24, 46

Basidiomata 21–81 mm high. Spore sac 10–23 mm diam., 8–12 mm high, hemispheric to depressed-globose. Exoperidium hyphal, velutinous to verrucose, composed by short, deciduous warts, irregularly loosing from the endoperidium, dark brown (6F5) to reddish brown (8F4). Endoperidium tough, with a smooth surface, color light brown (6D7), seen only in older basidiomes. Mouth definite, circular to elliptical, slightly projecting but not tubular, except in young basidiomes when unopened, color little distinct from the remaining endoperidium. Socket conspicuous, separate from the stipe, forming a lacerate but not membranous collar around the stipe apex. Gleba little pulverulent when mature, golden brown (5D7) to yellowish brown (5D8). Stipe 14–66 × 2.5–7 mm, cylindrical or compressed, erect to slightly incurved, with an expanded base composed by numerous and thin rhizomorphs, surface scaly-fibrillose, formed by longitudinally arranged scales (decortications of the stipe surface), color dark brown (6F7) to light brown (7D7), fistulose, context white.

Basidiospores 5–6 × 3.8–5 µm diam. (excluding ornamentation) or 6.2–7.2 × 5–6.2 µm diam. (including ornamentation), subglobose to globose, with a spiny ornamentation under light microscope, yellowish brown in KOH; under SEM the ornamentation is formed by conical anastomosed spines. Capillitium 2.5–8.4 µm diam. hyphae, with hyaline to stramineous walls, moderately thickened, lumen of variable diameter along the hyphae, septate and little branched (dichotomous). Exoperidium formed by fascicles of brown, thick-walled mycosclereids, mostly subcylindrical to irregular hyphae, 67–130 × 8–20 µm, covering the endoperidium surface. Endoperidium composed by short, subglobose, globose or irregular cells, with thick walls (mycosclereids), pale yellowish in KOH, 11–27 × 9–21 µm.

Examined specimens: BRAZIL. Rio Grande do Sul State. **Caçapava do Sul:** Pedra do Segredo, 01.V.2005, *V.G. Cortez 037/05* (SMDB 11.120). **Santa Maria:** Morro do Elefante, 12.IV.2003, *V.G. Cortez 040/03* (UFRN); Morro da Caturrita, 02.V.2006, *G. Coelho & V.G. Cortez 030/06* (ICN). **São Leopoldo:** *J. Rick* (PACA 15076); 1905, *J. Rick* (PACA 15089, as *T. verrucosum*); 1907, *J. Rick* (PACA 15086); 1930, *J.Rick* (PACA 15088, as *T. squamosum*). **Viamão:** 10.VI.1970, *M.H. Homrich & F.R. Schöenwald* (ICN 6146).

Distribution: Neotropical, widespread in South America (Wright 1987), Costa Rica (Calonge & Mata 2006) and Mexico (Guzmán et al. 1992). Brazil: Rio Grande do Sul (Wright 1987).

Discussion: *Tulostoma dumeticola* is distinguished by the verrucose, brown exoperidium, circular mouth, scaly stipe, and basidiospores with cylindrical warts under light microscope (Wright 1987). As shown under the SEM, the

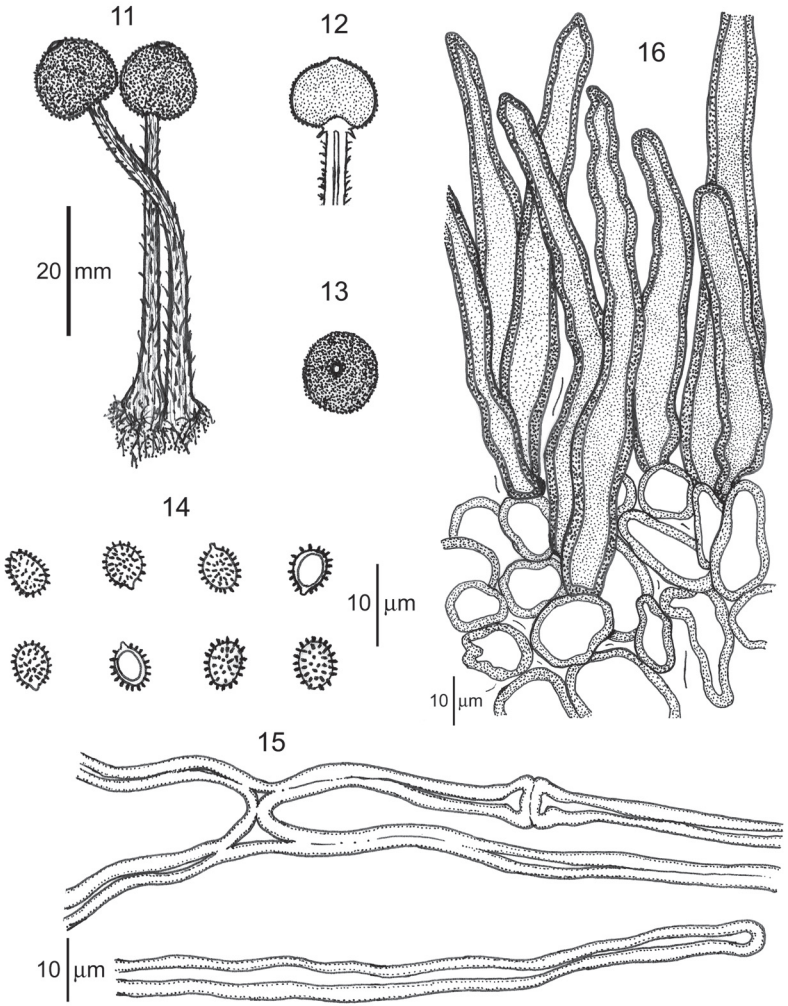

Fig. 11–16. *Tulostoma dumeticola.*
11. Basidiomata. 12. Partial section of basidioma. 13. Top view of spore sac.
14. Basidiospores. 15. Capillitium. 16. Detail of the exo- and endoperidium.

anastomosed crests on the basidiospores form a reticulate ornamentation. *Tulostoma matae* Calonge & J. Carranza, described from Costa Rica, is macroscopically similar, however differs in the ovoid to elliptical basidiospores (Calonge & Carranza 2003). As *T. exasperatum* and *T. rickii*, this species grows in subtropical forests of Rio Grande do Sul.

5. *Tulostoma exasperatum* Mont., Ann. Sci. Nat., Bot. Ser. 2, 8: 362, 1837.

Fig. 17–23, 25, 47

Basidiomata 25–50 mm high, growing solitary or gregarious on wood. Spore sac 13–17 mm diam., 8–11 mm high, hemispheric to depressed-globose. Exoperidium spiny, formed by short and conical spines of variable size (<1.5 mm in length), being more longer in younger basidiomes, color dark brown (6F8), becoming deciduous in maturity, falling from center/apex toward the margin/base of the spore sac, leaving conspicuous scars on endoperidium surface. Endoperidium papery to membranous, with a reticulate aspect due to the fall of the exoperidium spines, which leaves circular scars on endoperidium surface, color grayish orange (5B3) to brownish orange (5C3). Mouth definite, fibrillose-fimbriate, circular, slightly projecting to mammose, color little distinct from the remaining endoperidium. Socket present but inconspicuous, little separate from the stipe apex, and not forming a membranous collar. Gleba little pulverulent, brownish grey (5C3) to yellowish brown (5D5). Stipe 17–42 × 2.5–4 mm, cylindrical, straight to slightly incurved, with an expanded rhizomorphic base, surface wholly scaly, formed by longitudinally arranged scales (decortications of the stipe surface), color dark brown (6F8), fistulose, with flesh white to pale orange (5A3).

Basidiospores 4.5–6.5 µm diam. (excluding ornamentation) or 7.5–9.2 µm diam. (including ornamentation), globose, yellowish in KOH, with a reticulate ornamentation in light microscopy; under SEM, the clathrate pattern is observed. Capillitium 3.5–7.5 µm diam. hyphae, with stramineous and moderately thickened walls, lumen of variable diameter along the hyphae, septate and dichotomously branched. Exoperidium formed by fascicles of yellowish brown hyphae of variable shape, which form the spines of the exoperidium, usually short and with little thickened walls, very close. Endoperidium composed by long, subcylindrical to sinuous hyphae, 7.5–20 µm diam., with much thickened walls (mycosclereids), sometimes without a visible lumen, yellow in KOH.

Examined specimens: BRAZIL. Rio Grande do Sul State. **Campo Bom:** Estação Ecológica Municipal, 30.V.2007, *G.B. Ceolin & M.A. Reck* (ICN). **São Leopoldo:** 1930, *J. Rick* (PACA 15070); 1931, *J. Rick* (PACA 15083); 1932, *J. Rick* (BAFC 51656), *J. Rick* (PACA 15073, 15075, 15079, 15085). **Viamão:** Parque Estadual de Itapuã, 22.V.2004, *V.G. Cortez 034/04* (UFRN); 25.VI.2005, *R.M. Silveira 456* (ICN). No data (ICN 56084).

Distribution: Pantropical, in the Americas, Africa and Asia. Brazil: Paraíba, Pernambuco (Baseia & Galvão 2002), São Paulo (Bononi et al. 1984), Paraná (Meijer 2006), Santa Catarina, and Rio Grande do Sul (Wright 1987, Cortez et al. 2008a).

Discussion: *Tulostoma exasperatum*, like *T. cyclophorum* and *T. dumeticola,* is among the most abundant representatives of the genus in the area. The specimens grow solitary to densely gregarious on wood, as observed in several collections.

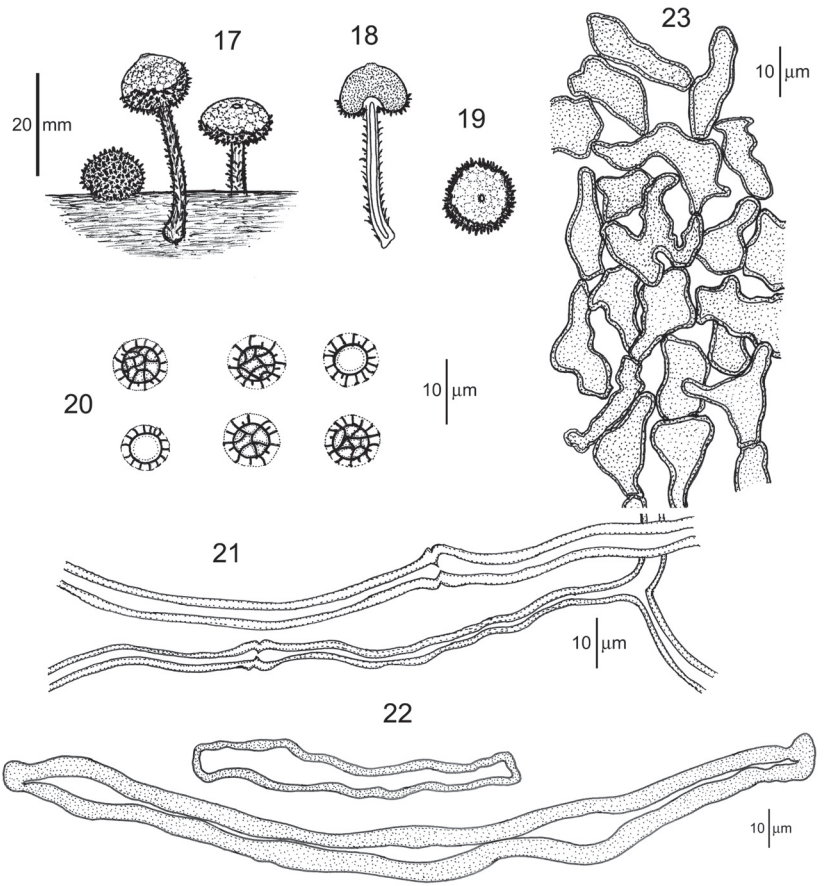

Fig. 17–23. *Tulostoma exasperatum*.
17. Basidiomata. 18. Section of basidioma. 19. Top view of spore sac. 20. Basidiospores. 21. Capillitium. 22. Endoperidium (mycosclereids). 23. Exoperidium.

The spiny exoperidium, reticulate ornamentation of the basidiospores, and lignicolous habit are the diagnostic features of this species (Wright 1987). Its distribution extends from Northeastern to South Brazil.

Although not described by Wright (1987), the endoperidium structure of *T. exasperatum* under light microscope presents similar hyphal elements to those of *T. cyclophorum*, which this author called mycosclereids. These thick-walled hyphae are found in other species like *T. dumeticola* and *T. matae*, and their presence is taxonomically significant in *Tulostoma*.

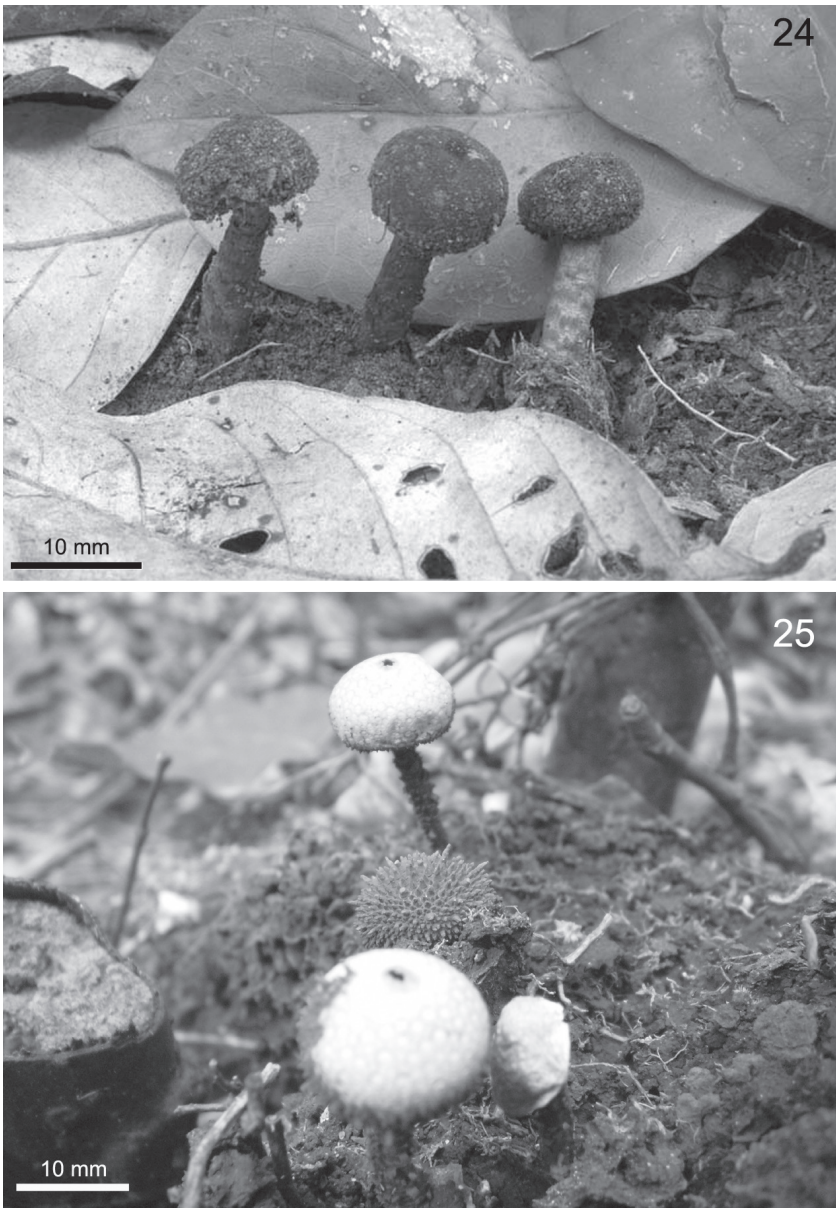

Fig. 24. *Tulostoma dumeticola* (Photo: G. Coelho).

Fig. 25. *Tulostoma exasperatum* (Photo: G.B. Ceolin).

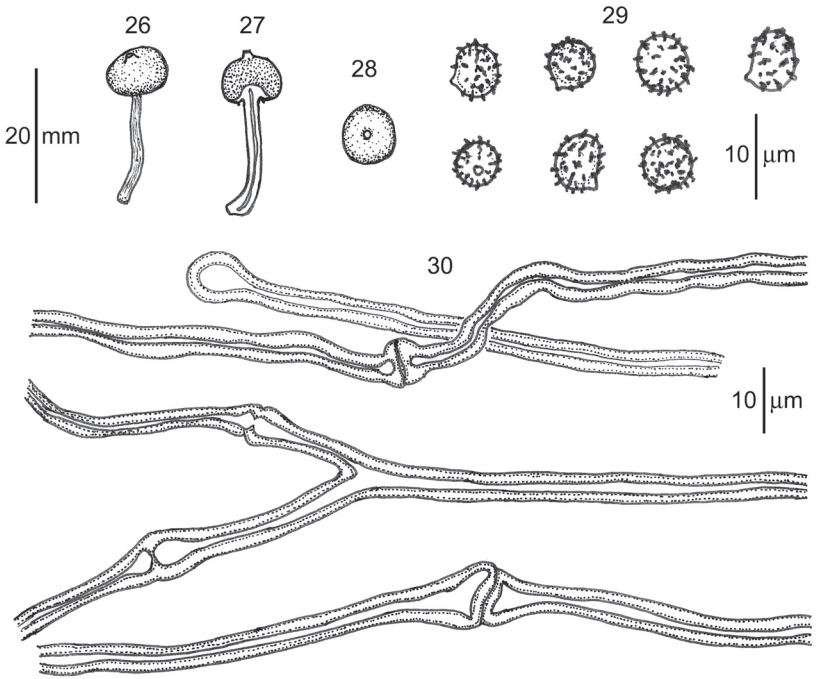

Fig. 26–30. *Tulostoma pygmaeum.*
26. Basidioma. 27. Section of basidioma. 28. Top view of spore sac.
29. Basidiospores. 30. Capillitium.

6. *Tulostoma pygmaeum* Lloyd, Tylostomeae, 16, 1906. Fig. 26–30, 37, 48

Basidiomata 20–23 mm high, with hypogeous stipe in early stages, then epigeous at maturity. Spore sac 8–12 mm diam., depressed-subglobose. Exoperidium hyphal, indistinct, appearing as remnants at the base of the endoperidial body, incrusted with soil particles and providing a verrucose aspect. Endoperidium papery, with a granulose to smooth surface, grey (6B1) to white (6A1). Mouth tubular, well-defined and projecting, with entire margin. Socket inconspicuous, very close to the stipe. Gleba pulverulent when mature, light brown (6C6–6C5). Stipe 16–18 × 2–3 mm, sometimes completely buried, slightly sinuous, surface with longitudinal striae and little scaly surface, brownish orange (5C4), base little expanded, fragile, hollow, with white context.

Basidiospores 6–7.5(–8.5) × 5.5–7.5 µm diam. (including ornamentation), subglobose to globose, with a coarsely verrucose to echinate ornamentation; under SEM the irregular ornamentation is formed by spines and warts which

sometimes are anastomosed. Capillitium 3.5–5(–7.5) µm diam. hyphae, with stramineous, thickened walls, with scattered and broad (7–12 µm) septa, and capitate apex. Exoperidium and endoperidium little differentiated from capillitium hyphae.

Examined specimens: BRAZIL. Rio Grande do Sul State. **Caçapava do Sul,** BR 392, 17.II.2008, *V.G. Cortez 028/08* (ICN), *V.G. Cortez 031/08* (ICN). **Santa Maria,** Parque Itaimbé, 28.V.2008, *V.G. Cortez 098/08* (ICN), 09.VI.2008, *V.G. Cortez 116/08* (ICN), 19.VI.2008, *V.G. Cortez 119/08* (SMDB 11.523).

Distribution: Africa, Australasia, Americas (Wright 1987).

Discussion: *Tulostoma pygmaeum* was described from North America, where it has been reported in xerophilous environments (Wright 1987). According to Moreno et al. (1995), the diagnostic features of the species are its small size, tubular mouth, hyphal exoperidium, and basidiospore ornamentation. Wright (1987) also noted the fragile nature of the stipe, a feature clearly observed in our studied specimens. Rick (1961) cited *T. pygmaeum* as "hic non inventum," only suspecting that it might occur in Rio Grande do Sul. However, we have located one specimen preserved at the herbarium PACA as *T. pygmaeum*, but the material is actually *T. cyclophorum* (see examined specimens). With the present finding, its occurrence in Brazil is confirmed.

7. ***Tulostoma rickii*** Lloyd, Tylostomeae: 20, 1906. Fig. 31–36, 38, 49

Basidiomata 56–81 mm high, epigeous. Spore sac 18–23 mm diam., subglobose. Exoperidium membranous, light orange (5A5) to yellowish brown (5D8), incrusted with soil particles, providing a verrucose surface. Endoperidium membranous, with a granulose surface light orange (5A4), adhered to the exoperidium. Mouth fimbriate, almost indistinct. Socket conspicuous to inconspicuous, with a membranous consistency, scaly. Gleba pulverulent when mature, brownish yellow (5C7) to golden brown (5D7). Stipe 42–71 × 5–7 mm, slightly sinuous, with longitudinal striae, scaly surface, light orange (5A5) to yellowish brown (5D6), base volviform with abundant soil particles adhered, hollow with white flesh.

Basidiospores 4.2–5 µm diam. (ornament excluded) or 6.7–8.4 µm (including ornamentation), globose, with a distinct reticulate ornamentation, which represent the 'wings' or 'spines' in optical section; under SEM, the clathrate pattern is observed. Capillitium 4.2–8.4 µm diam. hyphae, with hyaline to stramineous thickened walls, septate. Exoperidium formed by yellowish brown, thin-walled, interwoven and mostly collapsed hyphae, 2.5–5.5 µm diam. Endoperidium formed by hyaline, interwoven hyphae, with slightly thickened walls, 2–5 µm diam.

Examined specimens: BRAZIL. Rio Grande do Sul State. **São Leopoldo:** 1930, *J. Rick* (PACA 15072); spores of the holotype preserved at BAFC (51654).

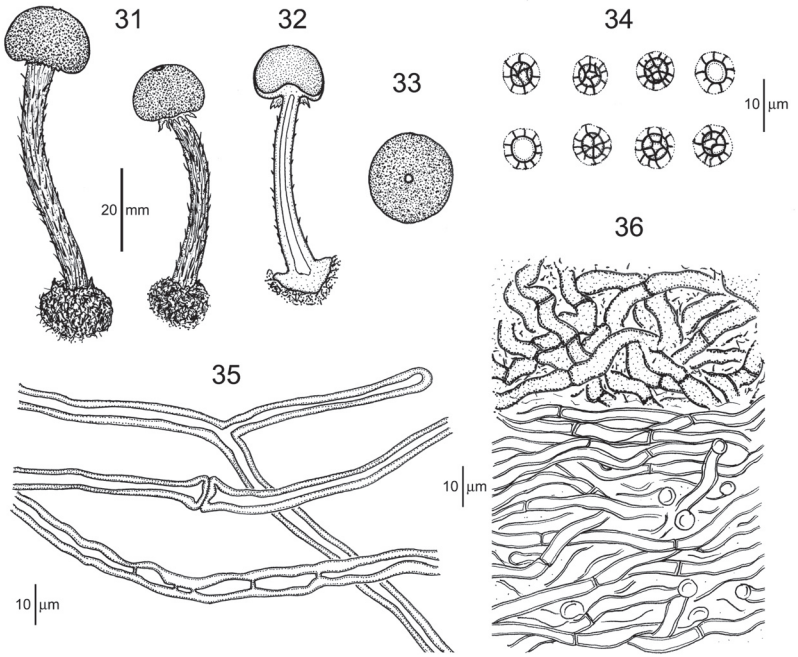

Fig. 31–36. *Tulostoma rickii*.
31. Basidiomata. 32. Section of basidioma. 33. Top view of spore sac.
34. Basidiospores. 35. Capillitium. 36. Detail of the exo- and endoperidium.

Additional specimens: Santa Catarina State. **Riqueza:** 27.XII.2006, *A.A. Spielmann & M.A. Sulzbacher 86* (SMDB 10.999).

Distribution: subtropical South America (Argentina and Brazil). Brazil: Santa Catarina (Cortez et al. 2008b) and Rio Grande do Sul (Wright 1987).

Discussion: *Tulostoma rickii* is characterized by the presence of a bulbous stipe base, resembling a volva and the reticulate basidiospores (Wright 1987). The latter are similar to those of *T. exasperatum*, but this is a lignicolous species with a conspicuously spiny exoperidium. Wright (1987) considered it a rare species, with known reports from Rio Grande do Sul (Rick 1961) and Santa Catarina (Cortez et al. 2008b) in Brazil, and northern Argentina.

8. *Tulostoma striatum* G. Cunn., Proc. Linn. Soc. N.S.W. 50: 255, 1925.
Fig. 39–43, 50

Basidiomata 23–30 mm high, growing on sand or sandy soil. Spore sac 8–10 mm diam., 9–10 mm high, globose. Exoperidium membranous, usually covered with sand grains and disappearing in older specimens. Endoperidium

Fig. 37. *Tulostoma pygmaeum* (Photo: V.G. Cortez).
Fig. 38. *Tulostoma rickii* (Photo: A.A. Spielmann).

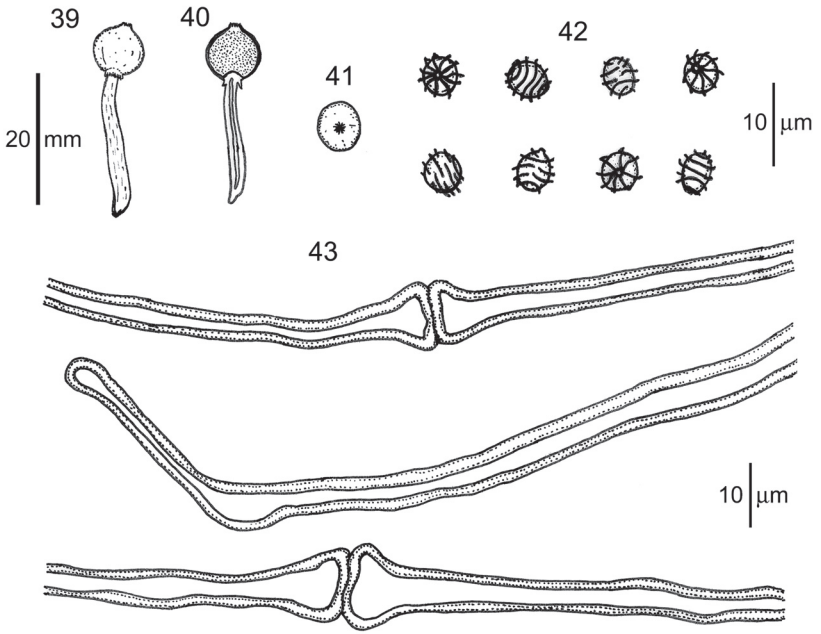

Fig. 39–43. *Tulostoma striatum.*
39. Basidioma. 40. Section of basidioma. 41. Top view of spore sac.
42. Basidiospores. 43. Capillitium.

membranous, with an almost smooth to slightly granulose surface, color dark blond (5D4) to grayish brown (5D3). Mouth definite, mammose, fibrillose to lacerated, slightly projecting, color indistinct from the endoperidium. Socket conspicuous, separate from the stipe, forming a membranous collar around the stipe apex, usually covered with sand. Gleba little pulverulent when mature, light brown (5D6). Stipe 15–22 × 3 mm, subcylindrical to clavate, slightly incurved, with an expanded base without visible rhizomorphs, surface smooth to rugulose or squamulose, color light orange (5A4) to grayish orange (5B4), fistulose, with white context.

Basidiospores 5.5–8.4 × 5–7.2 µm diam. (including ornamentation), subglobose to ovoid, yellowish brown in KOH, with a shortly-tubulose apiculus, striate ornamentation under light microscope; under SEM the ornamentation is conspicuously striate over a smooth surface. Capillitium 3.5–7.5 µm diam. hyphae, with subhyaline to stramineous and thick walls, sometimes presenting a granular and hyaline incrustation, lumen usually is reduced, septa and rare branches are present. Exoperidium and endoperidium little differentiated from the hyphae of the capillitium.

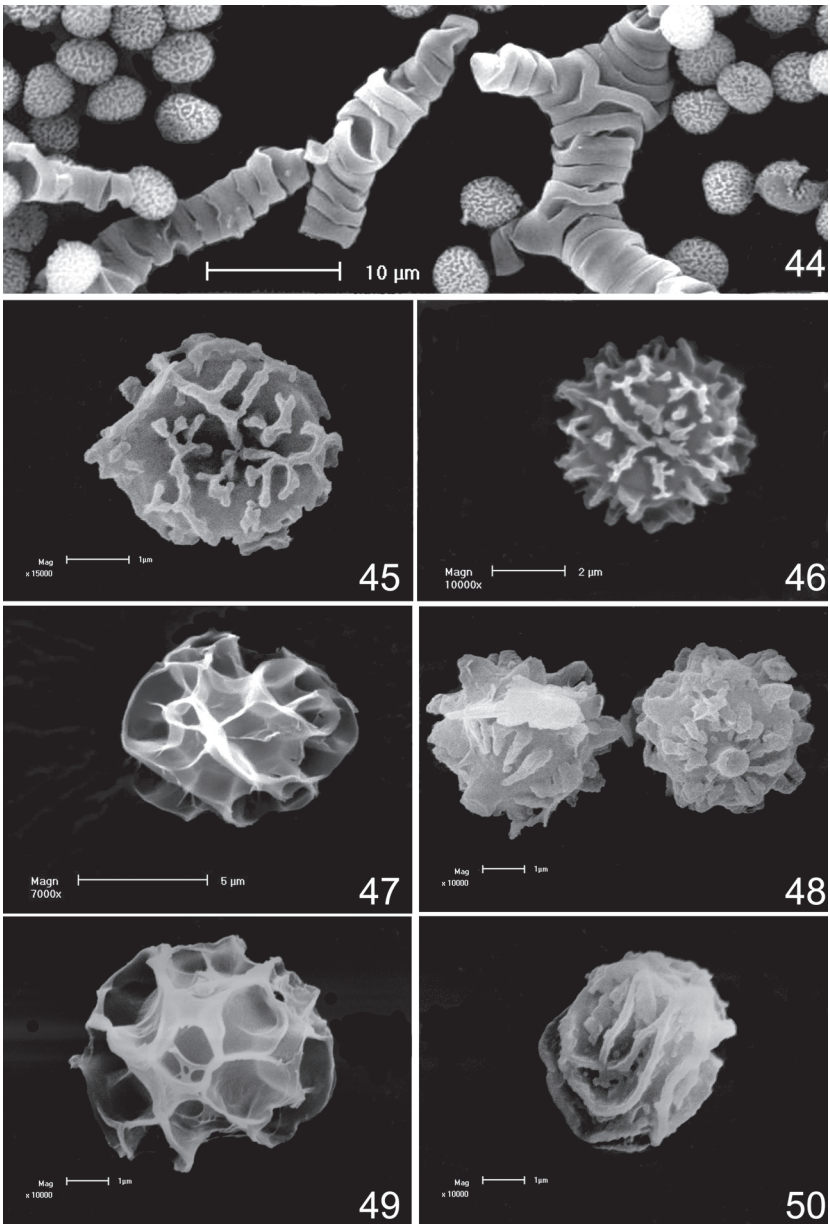

Fig. 44–50. SEM images of basidiospores and elaters.
44. *Battarrea phalloides* (basidiospores and elaters) . 45. *Tulostoma cyclophorum.* 46. *T. dumeticola.* 47. *T. exasperatum.* 48. *T. pygmaeum.* 49. *T. rickii.* 50. *T. striatum.*

Examined specimens: BRAZIL. Rio Grande do Sul State. **Balneário Pinhal:** IX.1961, *E.C. Vianna* (BAFC 51653, ICN 3560). **São Leopoldo:** 1930, *J. Rick* (PACA 15082).

Distribution: Widespread in Africa, Australasia, South, Central (Wright 1987) and North America (Oliver & Hosford 1979), and Europe (Altés & Moreno 1991). Brazil: only known in Rio Grande do Sul (Wright 1987).

Discussion: *Tulostoma striatum* is one of the most remarkable species in the genus because of the basidiospore ornamentation and for growing on sand or sandy places. *Tulostoma nigeriense* J.E. Wright presents similar basidiospores, but it differs in having a distinctive tubular mouth (Wright 1987).

Excluded or doubtful records

T. caespitosum Trab. – The material in Rick's collection (PACA 15068, as *T. mammosum*) was identified as 'cfr. *T. caespitosum*' by Dr. Jorge E. Wright, in 1972. Both macro- and microscopic features of the species (Wright 1987) are present in Rick's material and for this reason we consider it to be *T. caespitosum*. In view of the lack of any indication of its origin, we consider it a doubtful record, although we suspect it was probably collected by Rick in Rio Grande do Sul.

T. mammosum Fr. – This name is currently accepted as a synonym of *T. brumale* Pers. As far we know, the studied material in Rick's collection was never published. Part of his material is actually *T. caespitosum* (as discussed above), while another collection (BRAZIL. Rio Grande do Sul State: São Leopoldo, 1932, *J. Rick,* PACA 15077) consists of an unopened specimen of *Geastrum*.

T. rufum Lloyd – Reported by Rick (1930, 1961), but without reference to Brazilian specimens. This species is known in North America, Europe, and Africa (Wright 1987) and was only recently reported from northeastern Brazil by Silva et al. (2007a). Rick merely cited the species because he hypothesized that it could occur in south Brazil, although he had never collected it.

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